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Mathematics

Grade 12
(Advanced Level)

A REPORT CARD FOR ONTARIO

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PROVINCIAL REVIEWS

MATHEMATICS

Mathematics

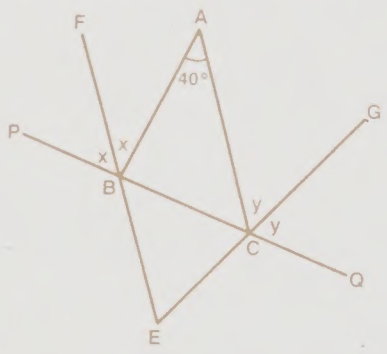
Grade 12 (Advanced Level)

Sample Questions From the Review

Selected questions from the Grade 12 mathematics review are reproduced below. Two boxes appear under each question. The left-hand box contains the percentage of students who answered the question correctly. The right-hand box contains the percentage of teachers who indicated that students had had the opportunity to learn the material or acquire the skills needed to answer the question. The opportunity-to-learn figure is not available for question 12.

The panel rating of students' performance is also given for each question.

1. Given the following diagram:



The degree measure of ∠BEC is:

a) 40°
b) 70°
c) 80°
d) 110°

67 91

Panel rating: satisfactory

This geometry question requires analysis and then application of properties of angles.

Introduction

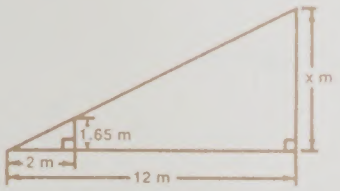
Provincial reviews form part of the Ministry of Education's ongoing commitment to the monitoring of school programs. The results serve to inform the public about the performance of the educational system in Ontario and to assist schools, school boards, and the Ministry of Education in improving teaching methods and raising the level of student achievement.

A provincial review of mathematics was conducted in selected Grade 12 advanced level classes in Ontario during the spring of 1990. The main questions answered by the review were "How well are Grade 12 students achieving the goals of the advanced level mathematics curriculum?" and "How are Grade 12 students taught mathematics at the advanced level?" Highlights of the results are listed below.

Highlights

- Grade 12 students in advanced level mathematics are achieving at levels judged to be satisfactory or better in half of the topics in the course; achievement was rated strong in one topic, satisfactory in five topics, marginal in five topics, and weak in one topic.
- Student achievement is strong only in the topic of similar figures.
- Student achievement is satisfactory in the following areas: congruence and parallelism, the circle, polynomials and equations, radicals, and process problems.
- The following were identified as areas of weakness: graphs of functions and relations, trigonometric functions, applications of trigonometric functions, exponential and logarithmic functions, graphs of second-degree relations, and absolute value.
- The enrolment in Grade 12 advanced level mathematics is 52 per cent male and 48 per cent female. Achievement levels are slightly higher for male students than for female students.
- The majority of students say they like mathematics and believe that mathematics is important for employment, is helpful to them outside school, and is equally important for boys and girls.
- The most commonly used methods for teaching Grade 12 advanced level mathematics are presentation of information to the class by chalkboard or overhead projector and assignment of individual work.
- Approximately half of the teachers say that their students have access to computers for mathematics, but 86 per cent of the students never use computers in mathematics class.
- Thirty-seven per cent of the students do more than two hours of mathematics homework per week, 22 per cent of the students do less than one hour of mathematics homework per week, and 5 per cent of the students do no mathematics homework. Twenty-seven per cent of the students receive help with mathematics from someone at home.

2. At a certain time of day a tree casts a shadow that is 12 m long. At the same time of day a man 1.65 m tall casts a shadow 2 m long.



The height of the tree is approximately:

a) 0.145 m
b) 9.9 m
c) 14.5 m
d) 990.0 m

86 84

Panel rating: strong

This question requires students to use a property of similar triangles to determine a length.

3. O is the centre of the circle below.

If ∠OPR = 28°, then the measurement of ∠PQR is:

a) 56°
b) 62°
c) 118°
d) 124°

51 61

Panel rating: satisfactory

This question requires students to use an angle property of the circle to calculate the measure of an angle.

4. Solve $|x - 2| = 5$.

38 95

Panel rating: weak

This question measures students' understanding of the concept of absolute value.

How was the review conducted?

Information was collected from students, teachers, and principals by means of questionnaires and mathematics test questions. The data in this report card are based on a provincial sample of English-language schools (4851 students and 175 teachers). In addition, 45 boards chose to have all of their English-language schools administer the instruments so that they could receive summary data at the board and school levels.

A detailed presentation of the results of the provincial review is contained in *A Report for Educators*. Participating schools and school boards have received reports containing local results. A provincial review was also conducted in French-language schools, and parallel reports are available in French.

What types of questions were students asked?

Most of the questions in the student booklets were multiple-choice questions, to which students responded by choosing the correct answer from four possible responses. Some questions required a written response, such as a numerical or algebraic answer, a complete solution to a problem, or an extended proof. The students were permitted to use calculators.

The assessment questions covered the following components of the mathematics curriculum:

1. Geometry:
- solving numerical problems and proving simple deductions using the properties of congruent triangles and parallel lines
- defining similar figures; solving numerical problems and proving simple deductions using the properties of similar triangles
- defining terms and proving properties associated with the geometry of the circle; using these properties in numerical problems

2. Relations and functions:
- graphing functions and relations
- sketching the graphs of trigonometric functions
- proving simple identities involving trigonometric functions; solving problems involving right triangles, oblique triangles, and trigonometric equations
- graphing exponential and logarithmic functions; solving problems involving these functions
- graphing circles with centres other than the origin; graphing ellipses and hyperbolas in standard position

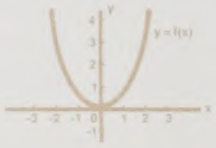
3. Algebraic operations:
- factoring polynomials and solving polynomial equations
- defining absolute value and solving equations and inequalities involving absolute value
- interpreting and evaluating powers with integral bases and rational exponents

4. Process problems:
- applying problem-solving strategies to unfamiliar problems

The questions were designed to assess abilities at three cognitive levels: recognition or recall and comprehension, application, and analysis or proof. Recognition or recall and comprehension questions required the student to recognize or recall some definition, concept, formula, or algorithm and to use it in a routine way requiring little analysis. Application questions required some analysis. Analysis or proof questions required considerable analysis or proof.

Selected questions from the assessment booklet are presented in the margins of this report card. The answers to these questions are also given.

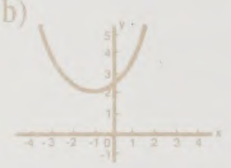
5. Examine the diagram below.



Which of the following is the graph of $y = \frac{1}{2}f(x-1)+2$?

a)

c)

b) 

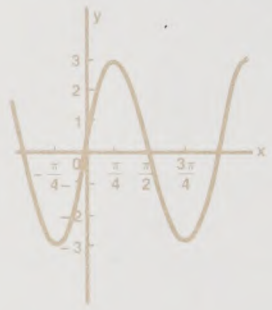
d)

41 98

Panel rating: marginal

This question on graphing measures students' understanding of the transformations that relate the graphs of two functions.

6. Examine the following diagram.



An equation of the curve is:

a) $y = 3\sin(2x)$ c) $y = 3\sin(x)$
b) $y = 3\cos(2x)$ d) $y = 3\cos(\frac{x}{2})$

42 94

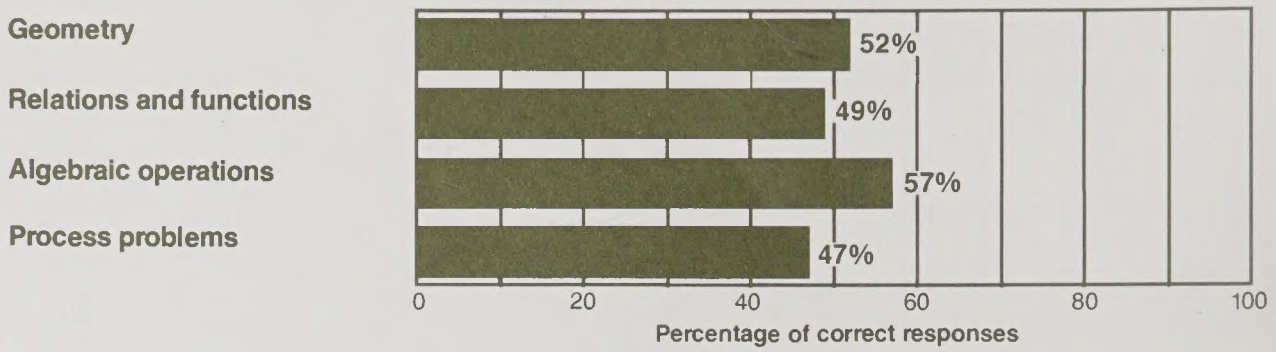
Panel rating: marginal

This question on trigonometric functions measures the students' understanding of periodicity.

How well did students perform?

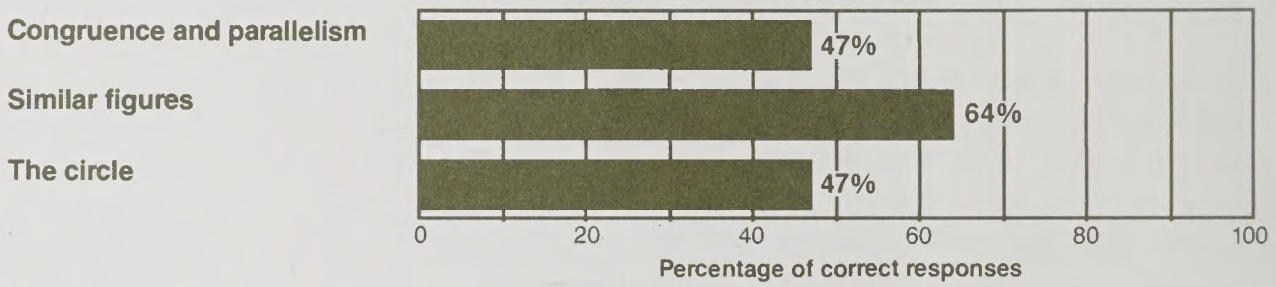
The average percentages of correct responses to questions in the main areas of the Grade 12 advanced level mathematics curriculum are presented in the following graph.

Summary of Student Achievement in Mathematics

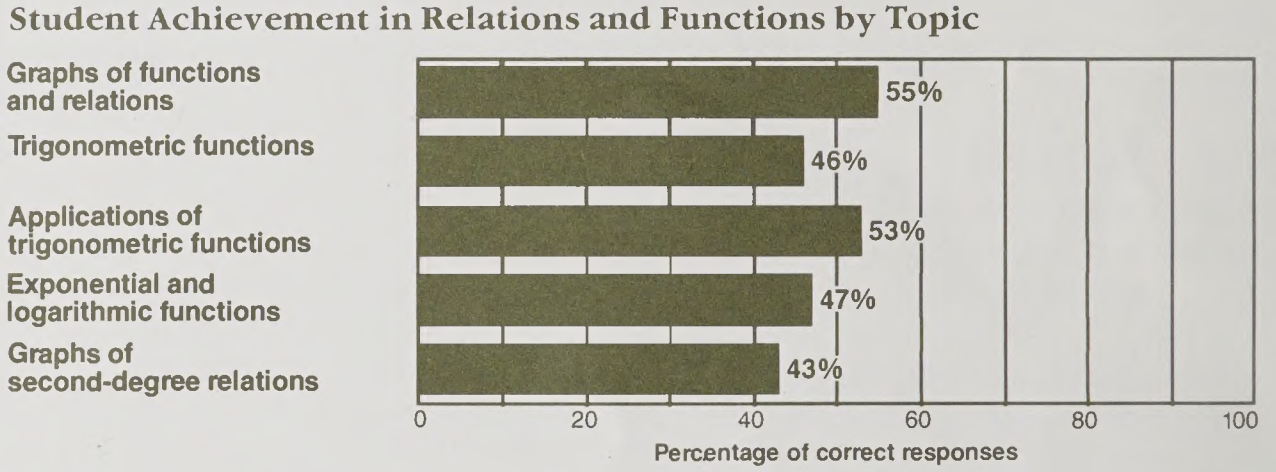


The graphs that follow show the percentages of correct responses for the specific topics within geometry, relations and functions, and algebraic operations.

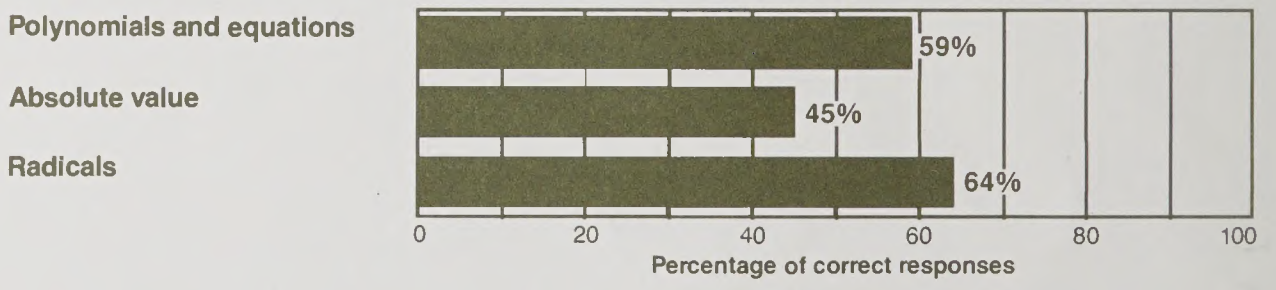
Student Achievement in Geometry by Topic



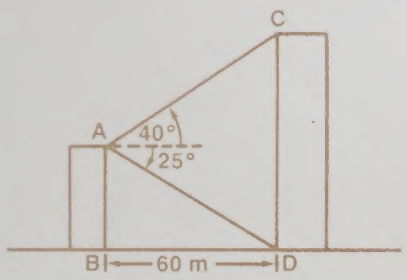
Student Achievement in Relations and Functions by Topic



Student Achievement in Algebraic Operations by Topic



7. Two buildings are 60 m apart. From the top of the smaller building, the angle of depression of the base of the taller building is 25° and the angle of elevation of the top is 40°.



The height of the taller building, to the nearest metre, is:

a) 28 m
b) 50 m
c) 78 m
d) 129 m

72 98

Panel rating: strong

This question requires the students to use trigonometry to calculate a length.

8. If $10^a = 4$, then $10^{(1+2a)}$ is equal to:

a) 26
b) 40
c) 160
d) 900

49 86

Panel rating: satisfactory

This question involving exponents requires analysis.

9. The transformation which maps the graph of $x^2 + y^2 = 9$ to the graph of $(x - 2)^2 + (y - 7)^2 = 9$ is:

a) a translation of 2 to the right and 7 up
b) a translation of 2 to the left and 7 down
c) a stretch in the x-direction of factor 2 and in the y-direction of factor 7
d) a stretch in the x-direction of factor $\frac{1}{2}$ and in the y-direction of factor $\frac{1}{7}$

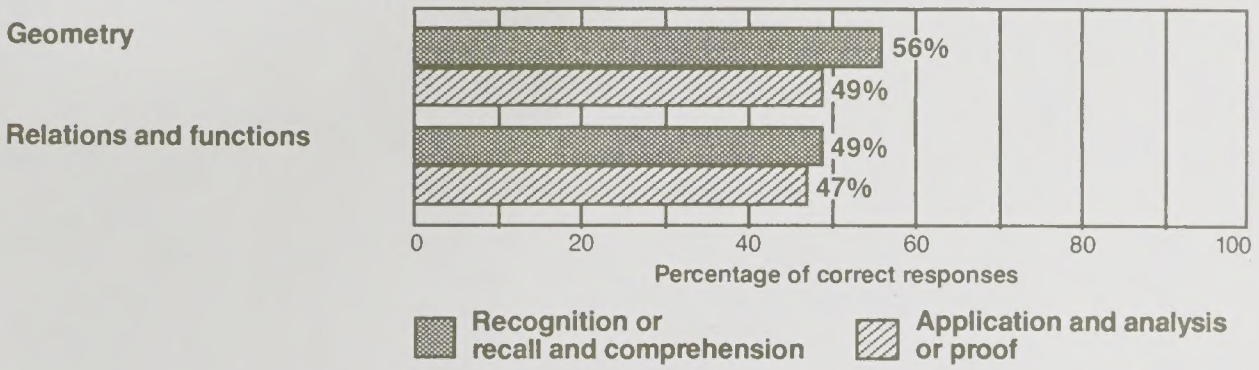
46 68

Panel rating: marginal

This question on graphs of second-degree relations measures the students' understanding of transformations that relate the graphs of two circles.

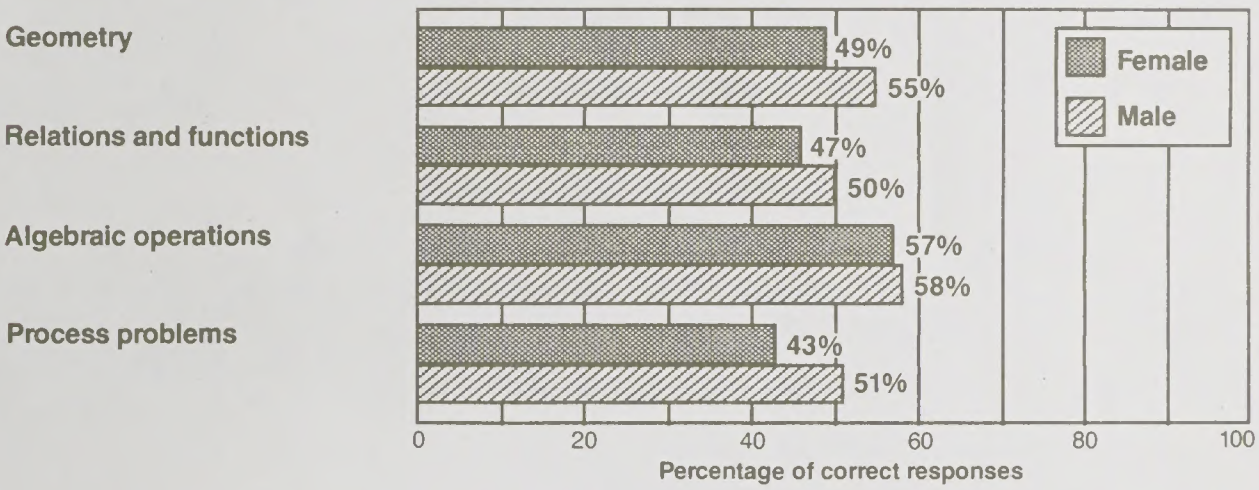
The following graph shows student achievement by cognitive level. Note that two of the cognitive abilities (application and analysis or proof) were combined for this analysis. A breakdown by cognitive level was not computed for algebraic operations because all of the questions on this topic involved recognition or recall and comprehension. All the process problems involved analysis.

Student Achievement by Cognitive Level



As shown in the following graph, achievement levels are slightly higher for male students than for female students for all topics. Student enrolment in the advanced level of Grade 12 mathematics is 52 per cent male and 48 per cent female.

Student Achievement by Gender



Interpretation panels composed of educators, parents, and trustees reviewed the test questions and the student results. Prior to seeing any student results, panel members established a standard for each question in the form of an expectation for student performance. Actual student achievement was then rated against these standards. Results were rated on a five-point scale: *superior, strong, satisfactory, marginal,* or *weak*. The panel ratings for the main curriculum areas and the specific topics are given below:

1. Geometry	***– satisfactory***
■ congruence and parallelism	*– satisfactory*
■ similar figures	*– strong*
■ the circle	*– satisfactory*
2. Relations and functions	***– marginal***
■ graphs of functions and relations	*– marginal*
■ trigonometric functions	*– marginal*
■ applications of trigonometric functions	*– marginal*
■ exponential and logarithmic functions	*– marginal*
■ graphs of second-degree relations	*– weak*

10. When $2x^3 - 5x^2 + 6x - 1$ is divided by $x + 2$ the quotient is:

a) $2x^2 - 9x + 15$
b) $2x^2 - x + 4$
c) $2x^2 - 9x + 24$
d) $2x^2 - 9x - 12$

58 98

Panel rating: satisfactory

This question measures students' ability to divide a polynomial by a binomial.

11. Evaluate $17^{0.75}$ correct to 2 decimal places.

70 90

Panel rating: marginal

This question measures students' ability to use a calculator to find an approximate value of a power with a decimal exponent.

12. On the beach during the summer Nina collected white shells and pink shells. One day she found 2 white shells and 1 pink shell. On the next day, she found 4 white shells and 4 pink shells, and on the third day she found 6 white shells and 7 pink shells. If the pattern continued, on what day did she find 30 more pink shells than white shells?

56

Panel rating: satisfactory

This process problem requires the students to select a strategy and then solve the problem.

Answers to Questions:

1. b	7. c
2. b	8. c
3. b	9. a
4. $x = -3$ or 7	10. c
5. a	11. 8.37
6. a	12. thirty-second day

3. Algebraic operations – ***satisfactory***
- polynomials and equations – *satisfactory*
- absolute value – *marginal*
- radicals – *satisfactory*

4. Process problems – ***satisfactory***

As shown by the panel ratings, student achievement is strongest in geometry. Some weaknesses are evident in the areas of relations and functions and absolute value.

How do students feel about mathematics?

Sixty-one per cent of the students say they like mathematics, 51 per cent say they are good in mathematics, and 33 per cent say that mathematics is difficult. Seventy-eight per cent of the students consider mathematics to be important for employment, 73 per cent say that mathematics helps them outside school, and 93 per cent say that mathematics is equally important for boys and girls.

How will the results of the review be used?

The provincial results have been provided to the committees currently working on the formulation of benchmarks and the restructuring of education in Ontario. This detailed information will assist the committees in their specification of instructional strategies and selection of resources. Steps will be taken to reinforce the positive aspects of the mathematics program that have been identified and to ensure that procedures are implemented to strengthen weak areas. Improvements in the mathematics program will be achieved through the following activities, which are part of the ministry's action plan:
- a review of the mathematics curriculum guideline, to determine what changes should be made
- an examination of needs in the area of resource development
- the identification of needs in the area of teacher in-service

The schools and school boards involved in the review have been provided with their own results and will interpret them and make recommendations for program improvement. School boards will develop local action plans based on a complete study of their data. Action at the board level should include the following:
- a review of local policy and program documents
- an assessment of implications for staff development
- an examination of needs in the area of development of local resource materials
- preparation of a report, to be submitted to the Ministry of Education, on the actions that have been taken and that are planned

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